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AUTHOR Beaudin, James A.; Merritt, Edwin T.; Cornett, Dave
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ABSTRACT

This report summarizes survey findings on Connecticut high school designs meeting future educational demands as well as state funding issues that are creating reimbursement difficulties, and presents an overview of specific problems and solutions the survey identified. Problem areas within the curriculum are highlighted and include scheduling; distance learning; individualized instruction; media centers; science labs; physical education; fine arts and auditorium; practical arts; administration, counseling, and medical; specialized programs; technology; facilities; and food programs. Security issues in tomorrow's high school are addressed as are problems and their solutions in the utilization of technology to reduce square footage needs and maximize state reimbursement funding. An example is provided explaining how New Milford High School was designed to meet both present and future educational needs by incorporating the latest technological systems. (GR)

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Designing for 21st Century Technology

First Annual School Construction Institute

ED 449 653

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James A. Beaudin, AIA
Principal
Fletcher-Thompson, Inc.

Edwin T. Merritt, Ed.D.
Director of Educational Research & Planning
Fletcher-Thompson, Inc.

Dave Cornett
Director
Education Technology Solutions

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INTRODUCTION

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James Gleich puts it well in his recent books, "Chaos" and "Fastec," in which he identifies the fact that we are in an increasingly accelerating mode of change. Our young people have learned to live in this environment. They absorb information, problem solve, and make decisions on the run. High schools of tomorrow must adapt to the new learning environment.

Increasingly we are talking about an individualized approach to future learning. We are talking about individualized educational prescriptions for young people utilizing technology based curriculum content, in an educational process where teachers guide and help young people navigate in cyberspace following their own paths, making their own discoveries, and generating intellectual energy.

The School Facility of Tomorrow

Our school buildings of tomorrow will house teachers who spend most of their time counseling, developing individual educational prescriptions, guiding rather than lecturing and testing, and making the assumption that students should spend most of their time in the process of inquiry, discovery, problem solving, and group interaction.

To meet new educational needs, architects are getting the call for facilities with more flexibility and technology. The school of yesterday featuring isolated classrooms of instruction is on its way out, and in its place, in response to teacher's requests, architects are designing spaces, which allow students to congregate, conference, interact, and telecommunicate.

Rapidly changing technology is one of the most critical issues affecting school construction. There are two driving forces that are requiring a new approach to school design. They are the pervasive use of computers and the collaborative, interactive and cooperative learning style in use today.

Pervasive use of computers refers to the fact that computers are becoming standard elements of most everything around us,

Use of computers to facilitate interactive and collaborative learning allows students to call for information that is required at a specific time for the specific problem at hand. This means that devices used in schools do not need as much long-term storage, processing power or battery power. Therefore, educational computing devices may be smaller, lower cost and have longer use between charges.

Electronic mail is fueling the growth of wireless data. This coupled with the need to provide communications access to workgroups throughout the school, makes the traditional placement of data jacks and computers at the back of a classroom nonfunctional. Each student needs to be able to access the web server based curriculum and their own work from

anywhere in the school as well as from home, in the town library, and even on vacation in a faraway land.

Collaboration requires appropriate classroom space with mobile furniture that can be configured into collaborative settings.

All building systems need to be closely coordinated with the demands of the new technology driven learning style.

The facilities component of a technology-enabled school is critical with regard to the effective use of multimedia instruction. Using computers and audiovisual tools, faculty and students alike should be capable of creating media intensive content. Both producing and consuming digital media will place demands on the design of classrooms, science labs, and other learning environments. These spaces will require appropriate lighting, acoustics, heating, cooling and power. User control of all of these elements to enable rapid and easy configuration of the space will be essential.

Fletcher Thompson Architects, of Bridgeport and Hartford, Connecticut, has recognized this period of change and is continuing to survey Connecticut school districts, with a focus on high school education, to provide information useful in designing new high schools with today's problems and solutions in mind.

PREFACE

Note: The following chapters do not focus on the specific details of State reimbursement calculations. However, reimbursement information is necessary to properly plan, design and market a school. One issue currently on the table in Connecticut relates to how far into the future an enrollment projection can be useable for reimbursement purposes. A year 2008 limit in an increasing enrollment decade may not be as favorable, in terms of reimbursement, as a 2012 limit (an 8 year versus 12 year projection).

Another issue revolves around suburban versus urban waiver allowances. The new urban Hartford Public High School is being built with a square foot per student space plan equal to that of the State's most affluent suburbs. But approximately 14% more of the space is reimbursable under waiver exception and, of course, the entire reimbursement is at a significantly higher rate.

Clearly legislative questions are being raised which relate to the timeliness of submitting a high school project for State approval.

RESEARCH FINDINGS

RESEARCH FINDINGS

During the 1999-year, Fletcher Thompson (FT) architects has been taking a look at problems and solutions associated with millennium high schools, through a survey and interview process. The findings are summarized below. A majority of the information included in this report has come from discussions with the design and project manager architects involved with nine high schools presently being worked on at FT, and eight high schools in the interview and pre-referendum stages.

As might be expected, most Connecticut high schools anticipate significant enrollment increases during the next decade with an enrollment plateau of sorts at the year 2008 mark. Consequently, most high schools will need more space. Expansion options range from renovation, to renovation expansion, to construction of a new school (regional, magnet, and/or local).

The public in many districts is questioning levels of State reimbursement and equity of the disbursement formula. Other issues relate to income tax/property tax equity and overall taxpayer burden. Where referendum validation opportunity exists, debate is intense and votes often defeat the project in question.

The call for a focus on basic education still has a position on center stage, and the related taxpayer referendum vote assures that program and design recommendations will be conservative. Local control theory influences Connecticut State legislation to the extent that statewide control in the area of school calendars, salary schedules, and curriculum/testing/competency mandates are hard to come by. Architecture reflects this attitude by producing relatively traditional structures reflecting local preference. There is very little room for change, creativity, and innovation under the watchful eye of the universal, omnipotent taxpayer.

We wonder if this constraint on a school district's ability to develop programs and approve building projects with an eye toward the future is wise.

Construction contracts are low bid oriented making it difficult to spend more for higher quality. Environmentally friendly building materials, high air quality HVAC systems, and sophisticated security mechanisms cost more than most building committees want to spend. Technology installations that improve instruction, and energy conservations that result in a rebate, are exceptions to the rule. Technology infrastructure installations that qualify for a federal E rate discount continue to be popular although many districts fail to apply for the funding in a timely fashion.

When submitting the infamous State Department of Education 049 form to be approved before a building project can start, the square footage issue becomes paramount. State formulas simply will not allow reimbursement for other than a basic structure. Anything beyond will be on the school district's tab (not reimbursed) and will be subject to scrutiny by the voters. This environment is a difficult arena in which to propose change.

The following is a summary overview look at high school problems and solutions identified by this survey:

CURRICULUM

Scheduling

High school course schedules vary from fixed to rotating with several block-scheduling variations. The eight period day is standard, although other variations exist and are installed mostly for fiscal reasons. Truly modular schedules, which vary by day or by week, are still too confusing, complicated, and expensive to administer.

Distance Learning

Distance learning, although desired, becomes a problem when synchronous "real time" instruction conflicts with multi-district schedule and calendar differences. It is hard to find even two school districts with the same class time slots other than those scheduled around an elongated lunch period.

Individualized Instruction

Teachers in general like to individualize instruction but are somewhat stymied by lack of net access, lack of distance learning availability knowledge, and time to assign and follow up.

Savvy educators are teaming with application service providers (ASP) to enable students to use thin computers designed at low costs to access the net only. These ASP's provide a wide array of software allowing teachers to efficiently individualize instruction.

In some districts, data warehousing and mining mechanisms allow teachers to access student information useful in educational prescription writing. Data review is particularly helpful in understanding student strengths and weaknesses as the teacher and student prepare for testing.

A wide variety of cutting edge programming calls for curriculum and building configurations that enhance higher order thinking, require collaboration, teach democratic process and advocate for moral maturity. Both building design and use of technology play a role in the success of such programs, whether it be a space in which to assemble the student body in a working configuration and/or the ability to have virtual school wide meetings. Central to the solution of all curriculum development problems is each district's ability to access and manage information.

Media Center

To do away with a portion of a media center's book stacks will result in a reduction of available hard cover reading material. Such a thought brings shivers akin to that experienced by "tree huggers" in the face of the preverbal chainsaw. But using today's technology, textbooks can be downloaded onto high quality resolution electronic reading devices, in less time than it takes to select one from the shelf and check it out. Future text selection from a well-connected virtual library environment will be almost infinite. Media Center planners can therefore begin to phase out book stacks and phase in electronic books access

mechanisms. The process will probably start first in the reference department. Making the assumption that the number and type of individual study stations in Media Centers will increase, and that the number of collaborative conference- teleconference rooms will also increase. It is safe, we think, to predict a 50% cutback in stack space and the use of approximately 50% of that cutback space for increased-improved individual workstations and collaborative environments. Therefore the net square footage reduction in the Media Center design could be as much as 25%.

Media specialists and librarians in general oppose a cutback in space and a reduction in stack shelving. Educators and taxpayers have been taught that the media center should be the focal point of the school and therefore should be larger, well lighted, air-conditioned, attractive, and comfortable. It is still hard for most to conceive of the effect that properly used technology will have on the design and function of the space.

Superintendents surveyed acknowledged the oncoming presence of the electronic reader but predicted that full scale adoption would be a slow evolutionary process.

Science Labs

New 9/10 grade science labs are gradually evolving into a one room combined presentation and virtual lab space. Lab experiments at that grade level, in some schools, are now being conducted virtually on computer screens eliminating the need for glassware, special furniture, and individualized gas, water, and power sources. It is much easier and more efficient to dissect "ADAM" virtually than in person! On the other side of the coin, for those with a need to move forward in the world of science, a well equipped lab with gas, water, electricity, and associated code/safety items is a necessity. Advanced placement chemistry, biology, and physics courses require a lab with real experiments, perhaps supplemented by virtual guidance.

The 9/10 grade all-purpose science labs do not need prep rooms or separate presentation classrooms. For this reason we can eliminate approximately 20% of a new high school's total science square footage.

Superintendents surveyed generally agreed with the use of a generic technologically supported 9/10 grade science classroom.

Physical Education

Unfortunately, we have not found ways in which technology will allow us to compress physical education space and/or schedules. In fact, one could easily make the argument that a modern high school's physical education facility should be increased in size. However, it is possible with sophisticated scheduling, the use of improved artificial turf, and the application of the inflatable roof and/or multi-purpose field house/superdome structure, to design and build a site, which provides multiple uses in a weatherproof and more cost effective environment.

It may also be possible to individualize physical education instruction by giving credit for out of school activities such as a soccer team or an exercise program done at home. Clearly physical education can be acquired, as needed, after or before regular school hours, but facility savings achieved by scheduling will probably be used up by increased facility demand by a wide variety of facility groups.

Superintendents generally agreed that athletic space is in increasingly high demand and that careful scheduling with an eye towards both maintenance and use could increase efficiency. One superintendent had requested a field house and another also considered one. All agreed that existing showers were not, and probably would not be, used but cited State guidelines prohibiting a cut back based on the required ratio of shower heads per student as the barrier to cut back.

Fine Arts and Auditorium

In spite of advances in technology, very little evidence can be found which supports reducing space related to art, music, dance, and other performing arts. If anything, student involvement in the arts is becoming greater. The importance of performing activities in the school and for the community is increasing at a rapid rate.

Space to store instruments, house audio/visual equipment, and space for individuals to practice on pianos and tubas is seen more and more in building specifications.

Communities look for auditoriums with large capacities so that everyone can gather to appreciate, celebrate and debate.

As an antidote to the type of anonymity associated with net interaction and virtual experience, it is perhaps important to have a large space for live practice and performance. While a square footage cutback is hard to recommend here, combined town/school use can make more efficient use of fine arts and auditorium space.

Superintendents in general desired auditoriums that had the capacity to house the entire student body but admitted that it was extremely difficult to sell the non-reimbursable cost of such a facility to the taxpayer.

Practical Arts (Industrial Arts, Unified Arts, and/or Technology)

As in the science area, much can be taught in practical arts with the computer in a virtual experience mode. But just as in the case of fine arts and advanced science, hands-on experience is necessary. One has to assume that to be able to saw, drill, and tape measure will always be important. To tighten a packing gland, wire a plug, and change a tire will also be with us for a while. Once again it is hard to envision a square footage cut in these areas. In fact, it is important to note the need for more space as the rapid escalation of computer repair training at the high school level becomes commonplace.

Superintendents noted the demise of enrollment in what used to be called industrial arts. They also noted a sharp reduction in the purchase of expensive equipment and supplies for that type of instruction. In an opposite direction, they cited increased education in both how to use and how to repair computers. In general they felt that some reduction in practical arts space would be beneficial. Several superintendents have been in the process of eliminating all "shops," with the exception of those, which were computer related.

Administration, Counselor, and Medical

It is a rare high school today that has adequate administration space. Assuming that conferencing is at the very heart of the administrative process, enough space should be made available so that nurses, counselors, administrators, recruiters, Planning and Placement teams, students, parents visiting dignitaries etc. can have adequate space. Needless to say, such space should be equipped with teleconferencing capability. High schools probably need a 20% addition in square footage here.

As the teacher becomes more of a counselor, the need for a student and traditional counselor interaction will diminish. However, an increase in the need for counselor/teacher interaction will take its place. The traditional counselor will spend more time training the teacher to counsel the student.

With the advent of genetic counseling and the dispensing of designer drugs, the nurse's office will, we think, expand into a nurse/doctor space with room for conference and probably for drug prescribing and distributing.

Superintendents agreed that increased nurse, counselor, and administrative space were important. They stressed the need for more conference room.

Specialized Programs

Classrooms equipped for instruction in childcare, health, TV production, and aqua/agriculture science are of interest.

Districts focusing on "college prep" have less interest in specialty programs as evidenced by the phase out of industrial arts instruction in their schools. On the other hand, districts with a relatively low college entrance rate were interested in adding more specialty courses.

Alternate schools designed to house the high school population who have behavior problems and seem to need a separate environment, appear to be growing in number. But they are not, for the most part, part of a new high school design. Rather they are housed in some unneeded space at a different location, housing from 3-8% of the 's high school population.
Superintendents' attitudes toward adding specialty programs seem to lack cohesion. New school proposals ranged the full gamut of having specialty rooms to not having specialty rooms. One superintendent wanted a class in jewelry making while another scoffed at the idea. The trend, if any existed, seemed to be away from offering specialty courses.

Technology

In general, high schools surveyed desired a smaller ratio of computers to students, with an emphasis on adding space and hardware for technology labs.

High schools are increasing use of the LAN/WAN network configurations and desiring more speed, by use of cable and/or T-1 access. Some mention of using wireless was made where flexibility of program, primarily in lab settings, called for mobile/laptop machines. Also, the use of satellite connectivity was desired.

High schools in general reported problems with network and particularly website development and related management and maintenance issues.

Superintendents acknowledged the importance of acquiring and utilizing technology in the improvement of instruction. They consistently referenced the coming ".com curriculum" and they felt that more leadership in this area should be forthcoming from the State Department of Education and the Regional Education centers. They felt hard pressed to keep up with related changes and admitted to being consistently behind the learning curve. They also complained that it was hard to hire staff who had knowledge of the field and who were willing to stay for a reasonable length of time.

Systems

Voice mail is desired but has been found to be difficult to introduce. In some cases, resistance by staff has related to the increased teacher workload and delay in parent/teacher access. In general, however, voice mail is welcomed.

Intercom reliability and audibility is a major problem for many high schools. Phone security and control issues are also a problem.

Districts like the idea of using cable to access the Internet and utilize distance learning, but where cable companies do not interconnect, districts involved cannot distance learn with each other.

High schools increasingly use video delivery systems for general communication and for special instructional purposes (such as a rocket "blast off").

Superintendents rely heavily on consultants to design and install systems. They complain regularly that the systems do not function properly.

Facilities

Parking adequacy and bus stacking space continue to be prevalent needs.

There is an increased need for more security related to the transportation problem. Students who must present "ID" entrance verification need efficient traffic flow patterns.

Video surveillance is becoming commonplace and brings with it space and related design questions.

Understanding and meeting code requirements of all kinds, particularly handicapped accessibility, is a concern. Sensitive fire alarm systems that become dirty, go off regularly, and require extensive maintenance are a nuisance. Air handling systems that include a maze of ducts, which become dirty, do not balance well, and are accused of being germ breeders, are a matter of concern during the heating season (particularly during the fall and spring "swing" seasons).

Automatic control systems installed to save money are desired but pose problems when they do not work properly.

Air conditioning exists in most high schools primarily in central office spaces and most recently in computer labs, but as education becomes more of a 24-hour 365-day proposition, total air conditioning is desired not only for comfort but also for health reasons. Allergy related sickness and associated demands by parents are on the increase. Special machinery to clean air in classrooms with special needs children is now being required by mandate.

Superintendents cite air quality and security as the top facility problems.

Food Programs

Most high schools continue with the traditional kitchen "in house" programs, although a move toward outside vendor offerings seems to continue.

The biggest problem, however, is the schools inability to move large numbers of eaters in and out of the cafeteria rapidly while at the same time giving students a wide-range menu. Automated credit, inventory, and bookkeeping systems with barcode access are being successfully utilized. Garbage control systems are of high importance.

Superintendents look to new school design solutions to provide appropriate building flow particularly with an eye toward cafeteria use.

Large School / Small School

Many argue that students may be more likely to be lonely and lost in a large school rather than a small school. This thought pattern may be losing momentum. The existence of an

"intranet community" in each new school will allow students to meet and get to know each other online by means of a wide variety of search and interactive modes.
Traditional limitations on communication, currently imposed by walls, distance, and general size will, in the future, be dramatically reduced. Large high schools are able to provide a wide variety of opportunity due to economies of scale and are cheaper to build per student. Therefore they may become tomorrow's school of choice.

A large high school for 3000 students has less square footage than that utilized by two 1500-student high schools.

Superintendents for the most part favor high schools in the 1000-1200-student range.

SUMMARY CONCLUSION

Gaining approval from the taxpayers, who tend to be conservative, to produce effective solutions to common problems is clearly a task of large proportions.

Many solutions are well understood by architects and by school superintendents.

Little communication takes place between the architect and the superintendent other than developing and presenting building specifications for Board of Education approval, and then turning the matter over to the Building Committee.

Few superintendents have the time to attend the numerous Building Committee meetings, choosing instead to delegate the responsibility or the decline the opportunity.

As a result, solutions to problems, which require conviction and foresight to formulate and significant leadership to implement, fall by the wayside.

The purpose of this research report is to identify problems and solutions with the hopes that dialogue amongst architects, educators and elected/appointed board and committee members would increase.

We hope that this report will lead to similar reports related to other levels of education (elementary and middle school), and that it will be used as districts contemplate working with architects, and as the various school communities put together seminars, conferences, and other interaction communication gatherings.

The existence of new and affordable technology has put us at the crossroad change. Working together, we can put our hands on the reins and make a difference.

NEW MILFORD HIGH SCHOOL

State of the Art Advancement:

The design of this high school for the present and the future education of New Milford's youth incorporates the latest technological systems. Using today's most sophisticated educational technology, the building's design integrates data, video and telecommunications along with providing high speed Internet access. All of the science labs, prep rooms and classrooms are fully equipped for computer use. A lecture hall seating 100 has been set up as a teleconferencing facility for use in distance learning. The lighting has been designed to take reflectivity of computer screens into account; the telephone system is computerized to offer voice mail messaging; and a sophisticated security system with cameras, intrusion detectors and access control is in place. Even the cafeteria will feature a state-of-the-art modern food service, and an observatory for the study of astronomy has been installed. Each of these technological advances has been successfully accommodated in the school's design.

From an operational standpoint, the Performing Arts Complex and the Athletic Complex have been designed as two separate entities - functioning separately, without their individual uses conflicting or disrupting the students' school day. The 750-seat auditorium in the Performing Arts Complex is truly a full performing arts facility with triple catwalks, digital lighting and a state-of-the-art sound control package. The stage has an orchestra pit that can be covered to provide more stage area and a fly tower with enough purchase lines to allow for storage of up to 30 scenery changes.

The new athletic field, with bleachers seating 1,500 spectators, will feature lighting for night games, a press box and an automatic irrigation system for the grass field, and the track around the playing field has an advanced running surface.

Innovation in Construction Techniques, Materials or Design:

From a design perspective, such a large building offers a particularly strong challenge to keep orientation within the building clear. Circulation corridors can get very long and confusing; therefore, nodes were introduced at the intersection of corridors, presenting an opportunity to create a set of unique spaces - special architectural spaces, such as rotunda, etc. At each node, the design team established clearly different points of arrival and took advantage to break up the otherwise long corridor. A true sense of place has been created at each node within the large facility; here one has the opportunity for a view of the exterior, allowing you to orient yourself relative to the rest of the building and the site. To further shorten the visual impact of lengthy corridors, patterns and different colors have been applied creatively.

Another design innovation is the introduction of the large ventilating louvers as architecturally decorative elements on the exterior facades of the building, which otherwise followed a fairly traditional motif as specifically requested by the Building Committee.

Contribution to the Community:

Beyond providing for the education of New Milford's children well into the future, the entire building is seen as a total community center, especially the Performing Arts and Athletic Complexes, serving the community at large. Encouraged by school administrators, community use of these two complexes in particular is planned both during and after school hours. Each complex can be separated from the rest of the school without interfering with the daily school routine or conflicting with life safety regulations.

Taken in its totality, this high school is the largest construction project ever undertaken in New Milford, and local officials, school administrators, and the students who have been involved throughout the entire process have seen the whole process as a learning experience.

The design of the high school was a determined effort to embrace a new campus-like design approach and to create a "gateway" building along Route 7 - creating a major civic statement welcoming travelers to New Milford and a landmark building that intentionally differentiate itself from its commercial and industrial neighbors currently lining Route 7.

Beyond these elements, the building design incorporated the selection of building systems, particularly the heating, ventilating and air conditioning system, with a proven long life expectancy along with projected long term energy efficiencies.

Sensitivity to the Environment and the Surroundings:

The opportunity to create a "gateway landmark" was a guiding principle in the design of this new high school. The new school succeeds in creating its own context - to not be anonymous - to establish a clear civic presence at the entry to New Milford. Set on an open plain with the mountains looming in the background, the building clearly and strongly establishes a strong profile that fills and defines the open space. The building's profile intentionally draws inspiration from the historic architectural forms of northwest Connecticut where it resides.

Environmentally, the building and site design raised the bar for meeting challenges such as:
Avoiding the wetlands, while also taking the added step of creating a wetland meadow and basin;

Correcting drainage and conditions contributing to flooding along Larson Farm Road;
Archeological research identified an ancient native American village/encampment so, an exhibition displaying the found artifacts and to tell the story was set aside in the new high school;

Expanding a sanitary sewer, initially designed to serve the new school alone, to also meet the needs of an adjacent housing development; and,

Purposefully orienting the building north/south to maximize the number of classrooms that get direct sunlight at some point during the day.

SECURITY IN THE HIGH SCHOOL
OF THE FUTURE

SECURITY IN THE HIGH SCHOOL OF THE FUTURE

Locked doors, video surveillance, police presence, metal detectors, drug sniffing dogs, curfews, speeches, and threats, while used with regularity, are gradually being seen as ineffective in the high schools of today.

High School of the Future

Staff will have the ability to know at all times what the student is attempting to accomplish and how well the process is going. Students will have individual educational plans (ILP's).

Profiles

Student profiles will indicate level and scope of academic achievement, abilities and capacities, personal characteristics, leadership skill, and areas of interest and involvement.

The student data warehousing system will be able to sort students by profile and provide early warning if behavior characteristics place that student in a category that is dangerous, bears watching, and/or needs professional attention.

Student Resource Officers

Student Resource Officers (SRO's) employed by the High School of the future should exist in pairs to support each other's activity, have access to administrative and police discipline systems and be trained to gain student trust enabling communication. They are used as resources to prevent trouble, provide help and meet needs. They can be all knowing ombudsmen.

Student Personnel Staff

The counseling department as it is commonly known along with the social work and psychologist departments provide professional support to students to help them develop and adjust their curricular and co-curricular programs. This staff group is trained in dealing with depression, anger, and a wide variety of mental illness problems.

The goal of the entire team of people, using the student data system, is to identify and understand existing problems and potential problems in the early stages and work with students to agree upon a plan of action in an environment where success is probable

Building Design for Security

The High School of the future must provide hallways, stairs, and meeting areas, which are open and free of alcoves, where clandestine interaction can take place. High school space most also provide areas that allow for collaboration, conversation, and general

communication. Individual teacher/student conference space and private group/staff meeting space is also needed.

Co-curricular Security

Coaches and advisors must have special training to identify potential student problems and make appropriate referrals. Today's media stories have frequent reports about coaches and parents who are allowed to have access to young people but are poor role models themselves. Staff with responsibilities in these areas should be certified as counselors and advisors and should have special student personnel training. A coach advisor will need appropriate places to talk to groups and individuals as well as information from the student data system, which may relate to student behavior outside of the academic environment

Security Systems

While attempts at student control rely more on understanding related information, having a good adult-student communication system, and providing appropriate education, the need for modern high tech security systems still exists. Video taping the halls, burglar alarm beams, heat, water, and fire alarm systems are still very important. Of growing importance is a weather forecasting and warning system where conditions specific to a particular building can be predicted and staff pro-activity can take place. Athletic fields, bus garages and buses also need their burglar/vandal alarms and student surveillance systems.

Faculty

Background checks, fingerprinting, and extensive portfolio information are needed for all staff members. Also, a communication system where administrators are told when a faculty member is compromising the system is important. Staff data is as important as student data.

Conclusion

It is the well-informed early warning system that provides the best security. Information provided by mechanical/electronic systems is an important source of information but a network of people who are dedicated to protecting people is the key to effective security in the High School of the Future.

REIMBURSEMENT; AN OVERVIEW

The State of Connecticut, as well as most other states, will reimburse school districts for the costs of new construction, renovation, and/or expansion in accordance with square foot reimbursement guidelines and in accordance with the overall percent of reimbursement allowed to each district calculated by formula on a need basis.

Renovation related to deferred maintenance and construction of other than basic educational space is not reimbursable. Per student calculation in Connecticut is based on an eight-year enrollment projection, with larger schools receiving less per pupil than smaller schools.

Waivers of the reimbursement rules are allowed for magnet school space and urban space. Both types of schools are eligible for waivers on a special needs basis. The magnet program must offer a specialized educational opportunity to draw enrollment, while on the other hand, the urban school must meet more specialized student needs.

Hartford High School

The recently approved design of a new 1900 student Hartford High School has the following characteristics and is fully reimbursable.

The school will be developed with 3 academies:

Academy for Excellence and Career Exploration-Seven Houses for Grade 9
Science and Technology Academy
Humanities and Arts Academy

Total Net =284,283 SF
Total Gross =393,139 SF (net x1.38)

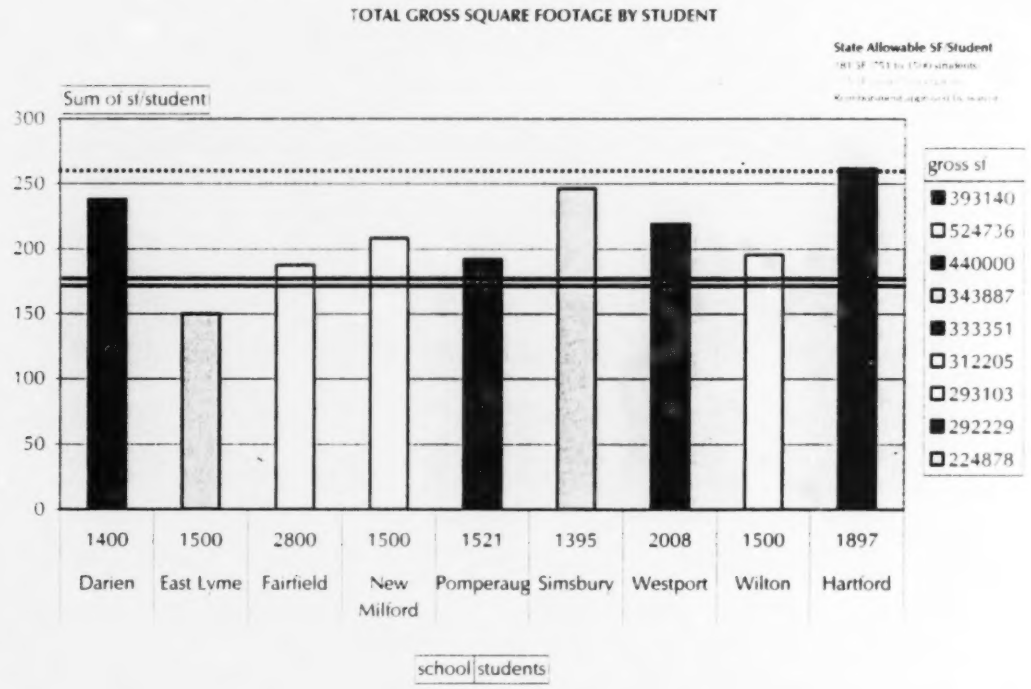
Magnet Schools are 100% reimbursable and comparative analysis is different because most magnet high schools offer partial day education.

High School of the Future
Design Strategy

The key to designing a new school to be 100% reimbursable is to keep the basic instructional space square footage as low as possible. Connecticut like most states is concerned only with net basic square feet per student. Hence a reduction of the size of twenty basic classrooms from 850 square feet to 700 square feet would produce, under the formula, 30,000 square feet that could be used elsewhere in specialized spaces.

High schools of today usually have designs which come in over reimbursable limits with the District/Town agreeing to pay full price for the additional square footage.

The following comparability diagram illustrates that with the exception of East Lyme, which was a like new renovation and expansion, all high schools in the sample are above the allowable reimbursable square foot levels.



"Net to Gross"

The net square foot area of educational space must be multiplied by a "net to gross" coefficient to provide for corridors, cooling towers, roof space, etc. The addition of a peaked roof together with a large mechanical cooling machinery space, such as used in New Milford, might for example drive the "net to gross" coefficient up. You will notice a "net to gross" figure of 1.8 in the New Milford High School and of 1.4 in the Ease Lyme High School

The Future

Connecticut reimbursement square foot allowances are higher than allowances nationwide according to Mr. David Wedge, head of the Connecticut Education Building Department, who surveys national allowances with some regularity. In a summer 2000 conversation with a representative from Fletcher-Thompson Architects he indicated that he felt that there would be no move, in the near future, to raise or lower the levels.

Since the state is under mandates of the recent Sheff vs. O'Neil case, to show progress in integrating urban and suburban population, generous reimbursement decisions are usually found in magnet and urban construction.

In addition, "like new" renovation will be reimbursed at new construction rates. The purpose of this allowance is to encourage fully reimbursed renovation.

The State now allows for reimbursement as construction proceeds, thereby reducing the amount of interest a district will need to pay waiting for reimbursement. Although some arbitrage of funds takes place with Town fund allocations, the State system does not allow for arbitrage with its funding.

Local energy reimbursements and federal "E-rate"(universal service) discounts are the other revenue generators. Energy reimbursements relate to programs offered by area utilities. "E-rate" reimbursement is offered by the federal government as a discount on funds companies expended for technology particularly, infrastructure wiring and telecommunications costs. "E-rate" funding must be applied for, usually 1½-years, in advance. Many building projects miss the opportunity to apply for "E-rate" funding because they miss the deadline. The value of these two reimbursements can amount from 1-2% of the total cost of the entire project's cost.

Summary Conclusion

The price tag of school construction projects is of concern to most taxpayers. Attempts to keep the price down and fully reimbursable must focus on keeping basic educational spaces as small as practically possible.

It will require knowledge and courage for Building Committees to reduce space when conventional wisdom calls for more space to encourage collaboration and communication and to avoid a claustrophobic feeling.

It is important for the Board of Education and the Superintendent to stay in touch with the building process to validate the appropriateness of design decisions. .

It is important to involve the entire school community in all phases of the development process.

It is important for the Board of Education and the Building Committee to understand the relationship of technology to the adjustment of space configuration. (See attached articles on "Technology").

If the building process has been followed carefully, as outlined above, the community may well have enough funding and community support to consider adding:

- A community center
- A natatorium
- A field house
- Full air conditioning
- Year round education
- Athletic fields
- Larger auditorium
- Other

UTILIZATION OF THE TECHNOLOGY

UTILIZATION OF TECHNOLOGY
A FUTURISTIC VISION OF TECHNOLOGY AND SQUARE FEET

As part of its "Problems and Solutions" research program, the architectural firm of Fletcher Thompson located in Bridgeport and Hartford, Connecticut, asked me to take a visionary look at technology as it might influence the design of a new millennium high school. In response, this broad-brush piece is offered to stimulate "what if" type thinking.

Although couched in the form of a research report and based to some extent on information gathered in an interview process involving numerous Superintendent's of Schools, I have strayed from the actual data and utilized interpretation to pique the reader's imagination to stimulate the creative thinking process. Perhaps some portion of the scenarios, which follow, will become a reality in cutting edge high schools of the next decade? Hopefully this piece well help educators, architects, building committees, and boards of education to think about ways in which technology can be utilized to save money and improve the educational process.

An examination of Connecticut State Department data shows that during the past decade the number of square feet per high school student has been steadily increasing in new Connecticut high schools. It is also clear that the square footage per student of a new high school often exceeds state standards, which results in lower reimbursement to the municipality. Therefore it seems prudent to look at ways in which the square footage of new high schools might be decreased.

The Classroom

Based on information gathered from forty Connecticut school districts, it was generally agreed, by those educators interviewed, that high school teachers would gradually become more facilitators of learning than presenters of information. In the future, they will spend more of their time working with students developing and reworking individual "educational learning prescriptions," than they will spend presenting actual material.

During the next decade, the school day probably will retain its present characteristics in terms of class periods and annual calendar, but the learning year will begin to approach a 365-day, 24-hour "year round" flavor. Students will work with their school related projects on the beach, in the ski lodge, and riding planes and trains, as the spirit moves them. Student-teacher interaction will in many cases be by telecommunication. Presentation of information will be by both Internet and lecture. Discussion of information presented will take place in small school groups and on the various nets.

The high school classroom of the future, because of changes in teaching-learning style, will undergo a transformation. It will in all probability consist of a well-equipped teaching station with a teacher-student-parent conferencing area and a flexible student seating format that allows for work/discussion stations for up to twenty-five plus students.

The student work/discussion stations will have room for wireless laptops, some reference material, and comfortable chairs. The laptops will have wireless access to the Internet. All relevant student communication will be via lap top screen or other electronic reader. There will be no attempt to include space in the classroom for book bags, and or other peripheral equipment and/or other furniture. The laptop bag with room for personal items will be all that the student will carry.

The classroom will have good air quality but need not have windows, which open and require space. All of the above can be designed into a 650 square foot area, which is approximately 20% less than we see in most modern classroom design schemes.

Lockers and Hallways

If each student accesses information via a laptop, palm top electronic reader, or similar wireless device, the need to carry books will be sharply reduced. Lockers for each student can therefore be eliminated and in their place student storage/coatrooms with some space needed for valid storage can be located in appropriate places. Laptops will be carried together with lunch from home and/or other personal items in a relatively small bag. As laptops become smaller the size of the bag will approximate a medium sized briefcase. The book bag will disappear because textbooks and other reading material will be accessed electronically.

Congregating in places currently designed around lockers and most often causing security problems will be eliminated. Related surveillance and security issues will be reduced. Therefore, factoring in the elimination of student lockers and the addition of a coatroom we might just be able to reduce hallway size by as much as 20%.

While it will take time to set up a comprehensive electronic reading system and while it may pay to wait for readers with better resolution than today's technology permits, it is the right time to design schools anticipating the change.

The Media Center

To do away with a portion of a media center's book stacks is to anticipate doing away with many traditional books. For many, such a thought brings shivers akin to that experienced by "tree huggers" in the face of the preverbal chainsaw. But, using today's technology, textbooks can be downloaded onto high quality resolution electronic reading devices, in less time than it takes to select one from the shelf and check it out. Future text selection from a well-connected virtual library environment will be almost infinite. Media Center planners can therefore begin to phase out book stacks and phase in electronic book access mechanisms. The process will probably start first in the reference department.

Making the assumption that the number and type of individual study stations in Media Centers will increase and assuming that the number of collaborative conference-teleconference rooms will also increase, it is safe, we think, to predict a 50% cutback in stack

space and the use of approximately 50% of that cutback space for increased and improved individual work stations and collaborative environments. Therefore the net square footage reduction in the Media Center design could be as much as 25%.

Science Labs

New 9 /10 grade science labs are gradually evolving into a one room "combined presentation and virtual lab space." Lab experiments at that grade level are now being conducted virtually on computer screens eliminating the need for glassware/special furniture and individualized gas/water and power sources. It is much easier and more efficient to dissect "ADAM" virtually than a fetal pig from storage. On the other side of the coin, for those with a need to move forward in the world of science, a well-equipped lab with gas/water/electricity and associated code/safety items is a necessity. Advanced placement chemistry, biology, and physics courses require a real lab with real experiments, perhaps supplemented by virtual guidance.

The 9 /10 grade all-purpose science lab does not need prep rooms and does not need separate presentation classrooms. For this reason we can eliminate approximately 20% of a new high school's total science square footage.

Large School - Small School

Today many argue that students will be more likely to be lonely and lost in a large school than in a small school. This thought pattern may be losing momentum. The existence of an "intranet community" in each new school will allow students to meet and get to know each other online by means of a wide variety of search and interactive modes.

Traditional limitations on communication currently imposed by walls, distance, and general size will, in the future, be dramatically reduced. Currently, a large high school for 3000 students has less square footage than that utilized by two 1500-student high schools.

Large high schools, because they are better able to provide a wide variety of opportunity due to economies of scale and because they are cheaper to build per student may therefore become tomorrow's schools of choice.

Busing -Global Position Satellite System

Assuming that each student's schedule will eventually be individualized, it will be possible to use that schedule to program related arrival, departure, and general school bus transportation needs.

To accommodate the individualized schedule, today's forty-bus district might be able to meet the need by running only twenty buses. This adjustment could be made by operating each bus all day long, rather than only early in the morning and again in the afternoon. The twenty

buses could have ten different district-wide routes and be programmed to give door-to-door service at the most economical time dictated by "chip reservation". For instance, the student would input his schedule for the day/or week and the transportation system would reserve his arrival and departure times. His bar-coded personal chip when read at the bus door would find his spot on the electronic route. A Global Position Satellite (GPS) system aboard the bus would navigate for the driver. The net result could be an approximately 20% reduction in the cost of bus operation based on the assumption that the technology to operate such a system would be significant and would cut into savings.

The system would also provide relief by downsizing pickup and drop-off site development problems. The student would arrive and depart from the high school in accordance with his/her schedule but with a much wider variation in arrival and departure times. It would not be uncommon for a student to arrive at 9Am and depart at 6PM etc., or arrive at 10AM and depart at 2PM.

Also, with each student wearing a personalized chip it will be possible for the school community via the GPS system to know where he/she is at all times assuming that the student has his chip.

While this suggestion may seem somewhat farfetched at the moment due to limitations of technology and the tradition of today's home and school schedules it should be noted that many of our school buses today leave and arrive at less than half capacity because students are on individual schedules and arrive and depart by other means. Recognizing existing travel patterns and staggering schedules with cooperation from staff, parents, and students could result in a sharp discount in transportation services provided without involving a chip or a GPS system.

Physical Education

Unfortunately, we have not found ways in which technology will allow us to compress physical education space and/or schedules. In fact, one could easily make the argument that a modern high school's physical education facility should be increased in size. However, it is possible with sophisticated scheduling, with the use of improved artificial turf, and with the application of the inflatable roof and/or multi-purpose field house/superdome structure to design and build a site, which provides multiple uses, in a weatherproof and more cost-effective environment. It is clear that a large high school building project has a better chance of including such facilities than any other municipal project.

Such a facility called a "hard dome" is under consideration in Rye Brook, New York. A 120,000 square foot sports dome to be constructed on vacant land at Port Chester Middle School would house a two level golf driving range and offer miniature golf, basketball courts, and convertible fields for baseball, soccer, football, and softball. The plan also calls for a track, lockers, volleyball court, food court, fitness center, video arcade, and computer training lab.

The structure would stand 65 feet high at its peak. Parking would accommodate 280 vehicles, with an extra 30-vehicle gate controlled lot for use by the school district. It may also be possible to individualize physical education instruction by giving credit for out of school activities, such as a soccer team, exercise program done at home, hiking trip, etc. Clearly, physical education can be acquired, as needed, after or before regular school hours, but facility savings achieved by scheduling will probably be used up by increased facility demand by a wide variety of facility groups.

Last but not least, "Do we really need all the shower square footage? " Girl's showers, particularly, are rarely used.

Fine Arts and the Auditorium

In spite of advances in technology, very little evidence can be found which favors reducing space related to art/music/dance and the other performing arts. If anything, student involvement in the arts is becoming greater. The importance of performing activities in the school and for the community is increasing at a rapid rate.

Space to store instruments, house audio/visual equipment, and space for individuals to practice on pianos and tubas is seen more and more in building specifications. Communities look for auditoriums with large capacity so that everyone can gather together to appreciate, celebrate, and debate.

As an antidote to the type of anonymity associated with net interaction and virtual experience, it is perhaps important to have a large space for live practice and performance. While a square footage cutback is hard to recommend here, combined town/school use can make more efficient use of fine arts and auditorium space.

Practical Arts

As in the science area, much can be taught in practical arts with the computer in a virtual experience mode. But, just as in the case of fine arts and advanced science, hands-on experience is necessary. One has to assume that the usage of a saw, drill, and tape measure will always be important. To be able to use a square, a level, and sandpaper properly will still be important in high school in our foreseeable future. To tighten a packing gland, wire a plug, and change a tire will also be with us for a while. So, once again it is hard to envision a square footage cut in these areas. In fact, it is important to note the need for more space as the rapid escalation of computer repair training at the high school level becomes commonplace.

Administrative/Guidance/ and Medical Space

As the teacher becomes more of a counselor, the need for student and traditional counselor interaction will diminish. However, an increase in the need for counselor/teacher interaction

will take place. The traditional counselor will spend time training the teacher to counsel the student.

With the advent of genetic counseling and the dispensing of designer drugs, the nurse's office will, we think, expand into a nurse/doctor space with room for conferencing and probably for drug prescribing and dispensing. Will we be dispensing brain enhancing designer drugs on test days?

It is a rare high school today that has adequate administration space. Assuming that conferencing is at the very heart of the administrative process, enough space should be made available so that nurses, counselors, administrators, recruiters, Planning and Placement teams, students, parents visiting dignitaries, and etc. can have adequate space. Needless to say, some rooms should be equipped with teleconferencing capability. High schools probably need a 20% addition in square footage here.

Reduce the High School of the Future by 20% of Its Square Footage

Our algebraic summary of square foot adds and deducts indicates that we have not quite achieved a 20% across the board reduction in the square footage of the modern high school. To reach a 20% reduction we offer distance-learning efficiency as a further potential reduction catalyst. Asynchronous distance learning done by keyboard and/or voice recognition is useful for individualized instruction. Synchronous/interactive full motion audio/video distance learning is good for presentations and discussion. The synchronous mode works best in states where yearly calendar and daily schedule are similar allowing for similar class schedules.

If we assume that today's high school is currently planned for 85% room utilization efficiency, proper use of both kinds of distance learning should be able to increase the room utilization rate to approximately 90%. Small classes in different high schools can, by this technique, be merged into normal class sizes, thereby reducing operational costs and the associated number of classrooms needed.

We think that distance-learning used on a relatively wide scale will balance our proposed square footage adds and thereby allow us to envision a high school in the foreseeable future with an overall 20% square footage reduction.

Consequently, if our new high school today costs $50 million, our high school of tomorrow, with non-inflated dollars and a 20% square footage reduction would cost significantly less. Operational costs could be reduced in a similar fashion.

EDITORIAL SUGGESTION (*tongue in cheek):*

Educators are good at spending saved money and in most cases their actions result in value added to the learning experience. So we suggest that the 20% savings be split with the tax payer with the net result being that the high school of the foreseeable future could wind up adding value to the learning experience and costing the taxpayer less.

Perhaps 50% of the square foot cutback savings should be designated to pay for the technology necessary to make the savings happen assuming that most of the new technology would also provide for value added education. This we think would make for a "Win-Win" experience.

NOTE: This futuristic sketch has been developed on the theory that a figment of imagination has a good chance of spawning a teaspoon of practicality.

INTERNET 2 AND HIGHER EDUCATION FACILITIES

Educational mandates and opportunities associated with the existence of an "Internet 2"-type backbone will require new thinking as college presidents commission new building projects and as architects design higher educational facilities. Library/media centers and classrooms will require access to technologically transmitted information and new space configurations that facilitate that data transmission. Across the nation, states are installing high-speed Internet backbones. In May, 2000 the Connecticut General Assembly approved House Bill #5737 authorizing funding or installation of an "Internet 2"-type state communication backbone throughout Connecticut. This is for the purpose of tying higher education, state libraries, and K-12 schools together with the ability to share high-bandwidth content, such as full-motion video on demand. Such a backbone already exists in New York and fifteen other states.

The Connecticut "Internet 2" is being developed on a track similar to a large federal government project called the Next Generation Internet (NGI). Both projects use high connection performance to enhance the existing Internet infrastructure providing both vast digital libraries and virtual libraries.

Connecticut "Internet 2" Legislation

The new Connecticut legislation is modeled after legislation already existing in approximately fifteen other states. It establishes a Commission for Educational Technology within the state's Department of Information Technology, for administrative purposes only; this Department will oversee and fund the development of educational technology statewide. The Commission shall:

a. Provide access for all public libraries and libraries at institutions of higher education to a core set of on-line full text resources;

b. Ensure that institutions of higher education offer a wide range of course and degree programs via the Internet and through other synchronous and asynchronous methods;

c. Allow for the transmission of video, voice, and data transmission to every library, school, regional educational service center, and institution of higher education;

d. Include an assessment of the telecommunications, hardware, software, and other services that will be needed to improve education. Measure the availability and usage of Internet access sites available to the public. These include, but are not limited to, those maintained by state and local government agencies, libraries, schools, institutions of higher education, nonprofit organizations, businesses, and other organizations. Also, to recommend strategies for reducing the disparities in the Internet accessibility and usage across the state and among all potential users; and,

e. Establish methods and procedures to ensure the maximum involvement of members of the public, educators, librarians, representatives of higher education, the legislature, and local officials in educational technology matters and organize, as necessary, advisory boards consisting of individuals with expertise in a particular discipline significant to the work of the commission.

In the same Act, the legislators called for a high technology research and development program for the purpose of promoting collaboration among businesses, colleges, and universities in the state in advanced materials, bioscience, energy and environment systems, information technology, applied optics microelectronics and other high technology fields. The program was also charged with establishing programs to attract and retain residents with postsecondary education in science, engineering, mathematics and other disciplines that are essential or advisable to the development and application of technology.

Facility Planning and "Internet 2"

As the world continues to rely increasingly on technology, there has been an increased demand for distance learning solutions. Higher Education facilities need more facility space for data output, input, processing and storage. College libraries must be equipped with electronic download and reading equipment to use worldwide virtual libraries. Architects and educators will need to make space determinations on needs for hardcover and textbook material.

Conferencing, collaboration, and problem solving have become the center of educational learning process, calling for dedicated space. Classrooms must provide flexibility to accommodate these group functions.

Modern educational theory also requires more individualized programs of study including opportunities for students to proceed at their own speed and capacity. Related space requirements call for professor/student conference modules, which have access to student data.

The technological infrastructure must be specified and installed with quality in mind and redundancy where needed. Present day student/staff frustration associated with technology malfunction to some extent grows out of the quality of design, construction and installation.

Fletcher Thompson Services

Fletcher Thompson prides itself on understanding the relationship of the new technology to architecture and the use of technology to assess needs and generate solutions. Our architects, engineers and interior designers understand the importance of developing an accurate database before attempting to develop a solution. Our data is warehoused in an inter-related base, which allows for a comparative analysis of different projects. In many cases, the information is mined to determine questions, which should be asked but were overlooked.

Fletcher Thompson applauds the Connecticut legislature and other states for authorizing the "Internet 2" backbone. We appreciate and embrace the changes technology generates in the design process.

How To Get More Information

Note: the author is the Director of Educational Planning and Research for Fletcher-Thompson, Inc., Architecture / Engineering / Interior Design, and he is also a member of the Connecticut Technology Commission created by the Internet 2 legislation. If you would like additional information about "Internet 2" or Fletcher Thompson, please call Ted Merritt at (203-366-5441) or email him at tmerritt@ftae.com

ARTICLES AND OTHER INFORMATION

Due to copyright restrictions, the articles are not included in the ERIC document. A bibliography of these articles is included instead.

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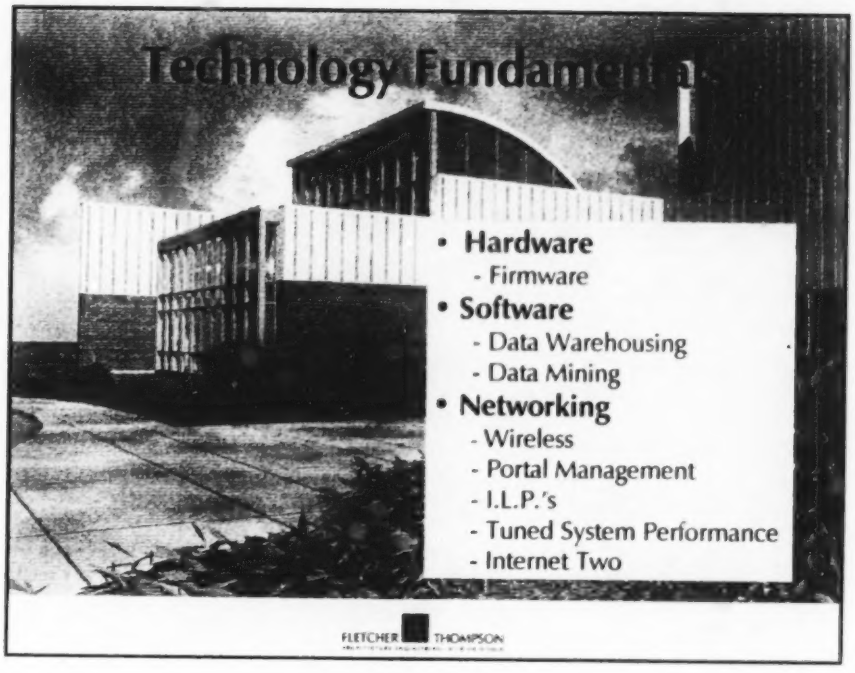

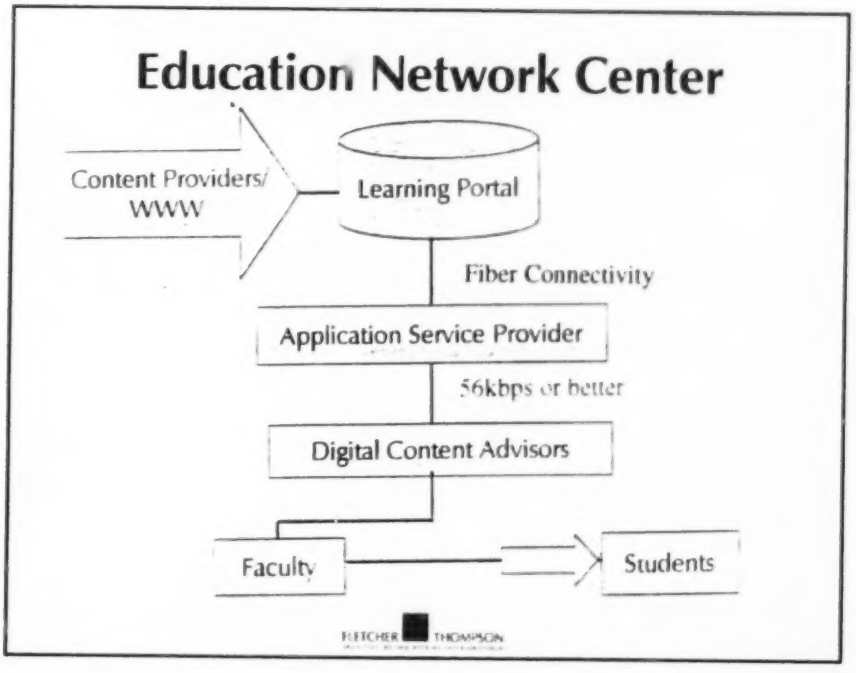

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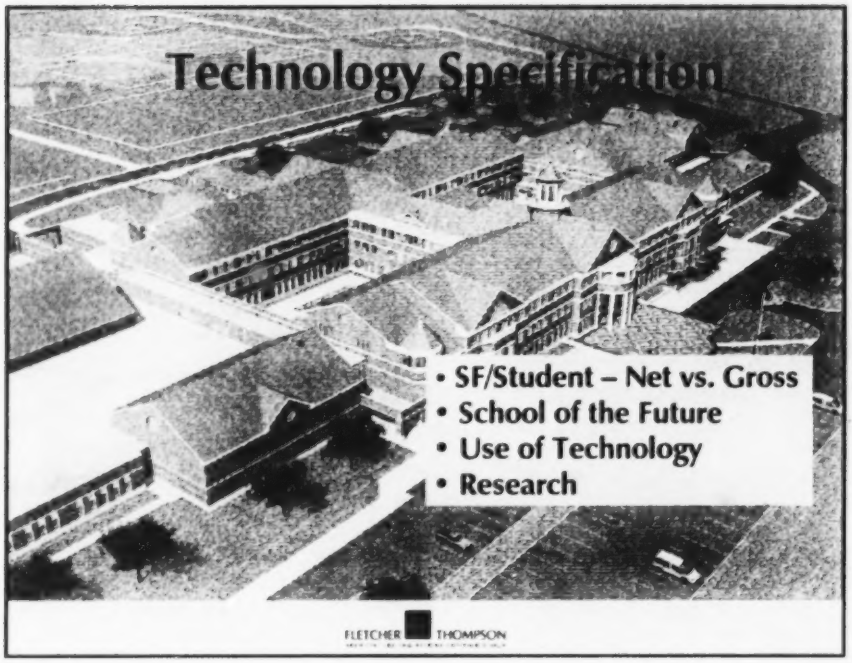
Technology Specification
• SF/Student – Net vs. Gross
• School of the Future
• Use of Technology
• Research
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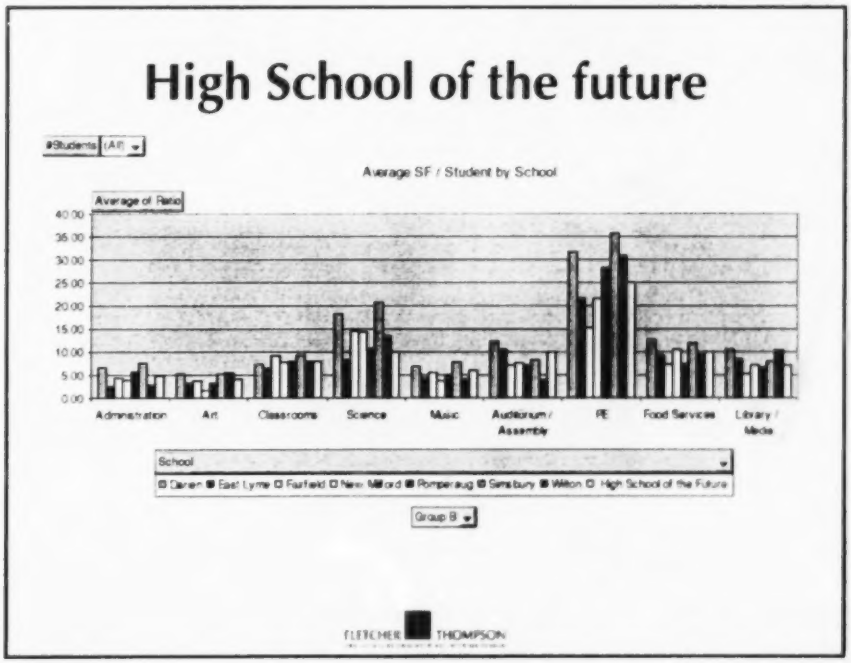
High School of the future
#Students (All)
Average SF / Student by School
Average of Ratio
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
Administration
Art
Classrooms
Science
Music
Auditorium / Assembly
PE
Food Services
Library / Media
School
Darien
East Lyme
Fairfield
New Milford
Pomperaug
Simsbury
Wilton
High School of the Future
Group B
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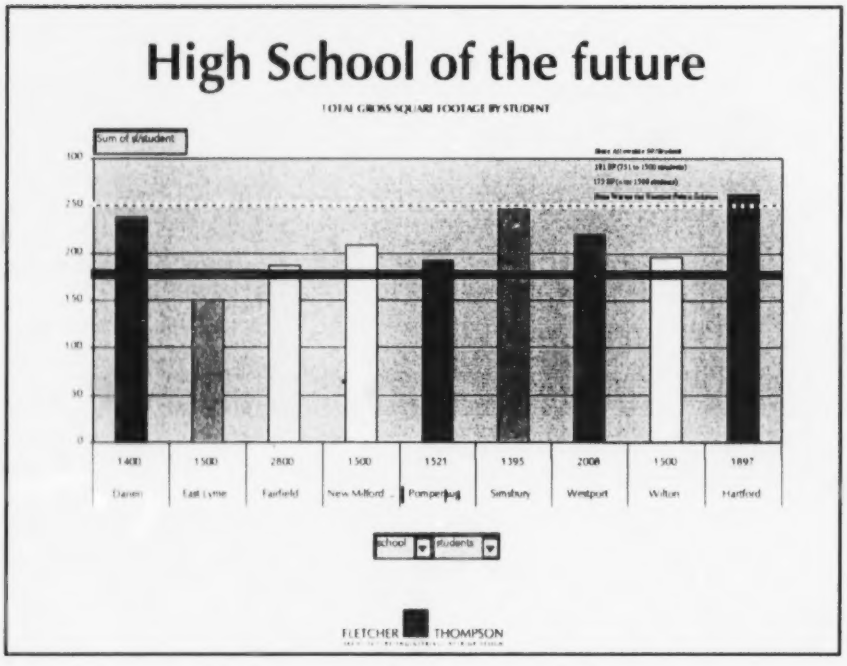
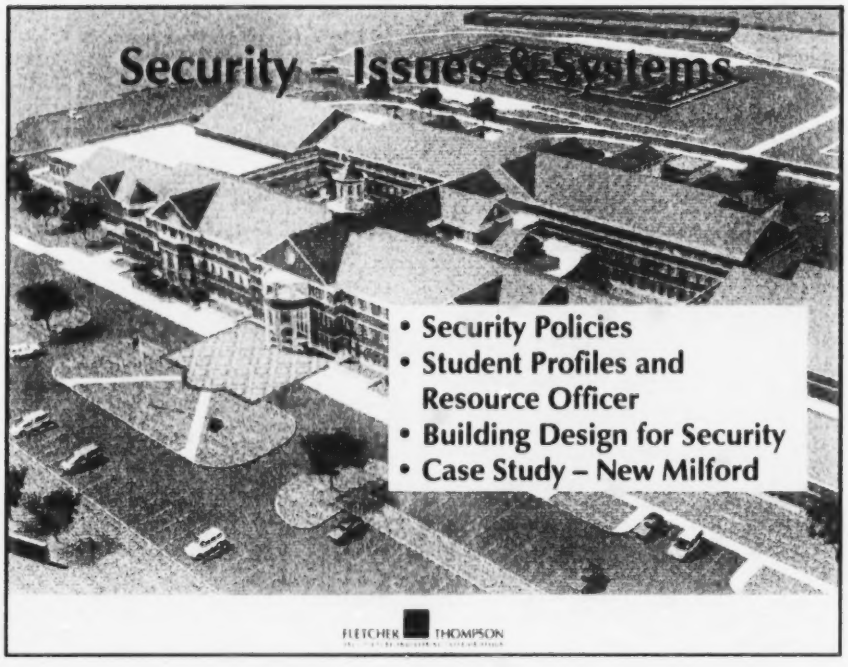
High School of the future




Security – Issues & Systems
• Security Policies
• Student Profiles and Resource Officer
• Building Design for Security
• Case Study – New Milford
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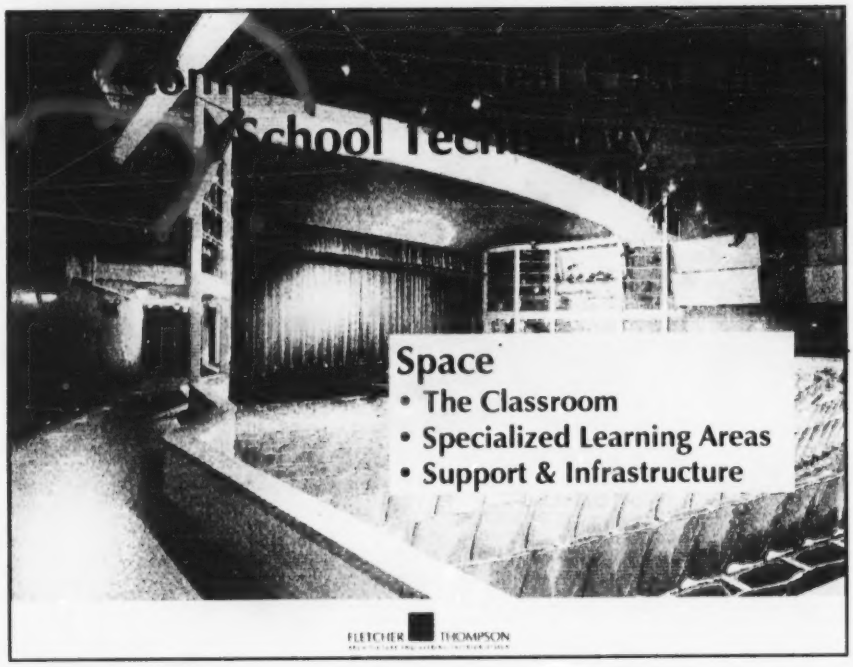

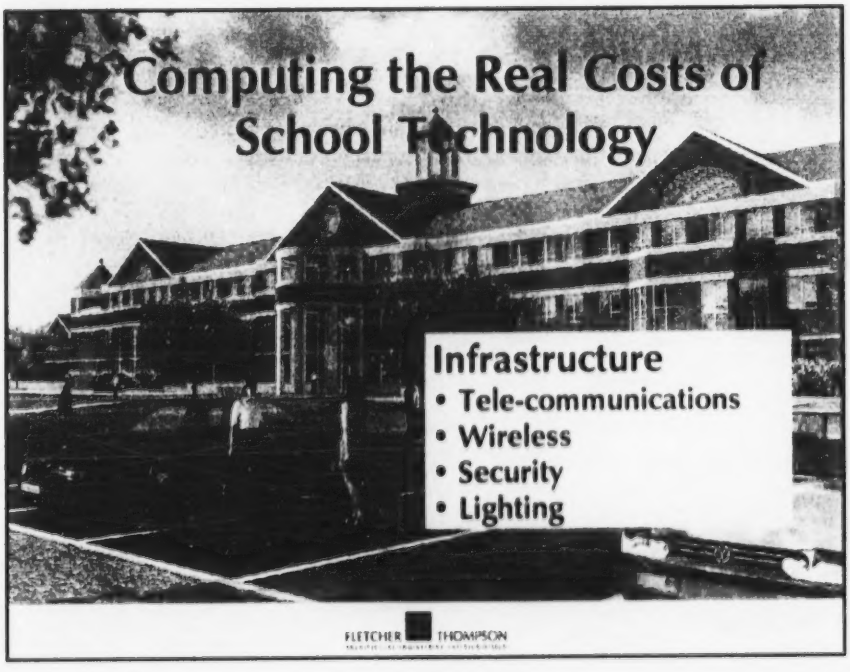

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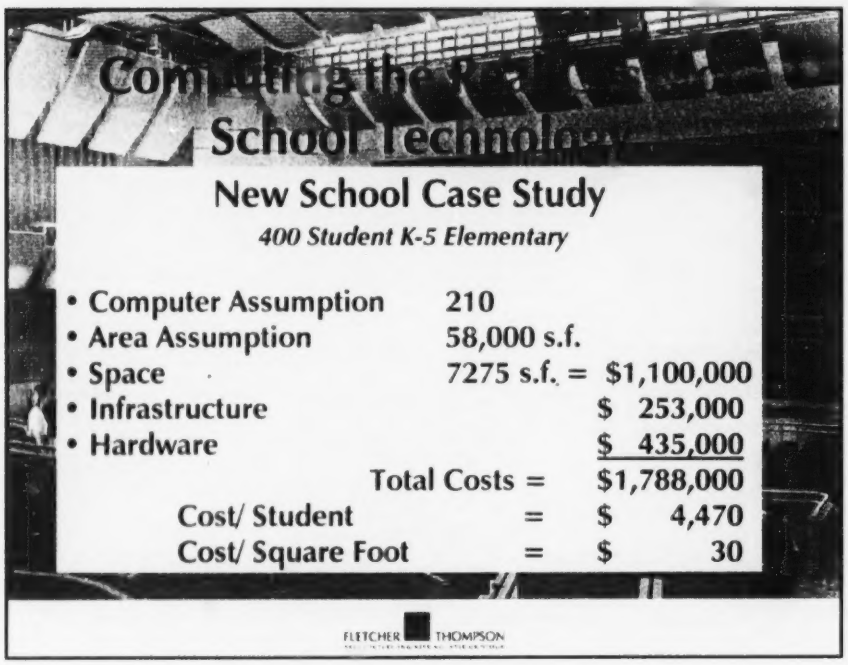
School Technology
New School Case Study
400 Student K-5 Elementary
• Computer Assumption 210
• Area Assumption 58,000 s.f.
• Space 7275 s.f. = $1,100,000
• Infrastructure $ 253,000
• Hardware $ 435,000
Total Costs = $1,788,000
Cost/ Student = $ 4,470
Cost/ Square Foot = $ 30
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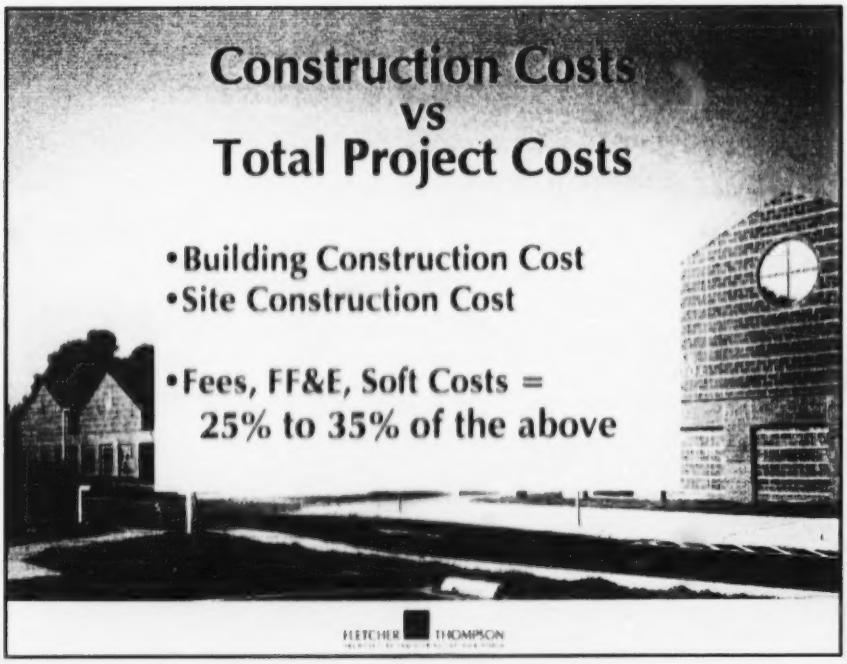

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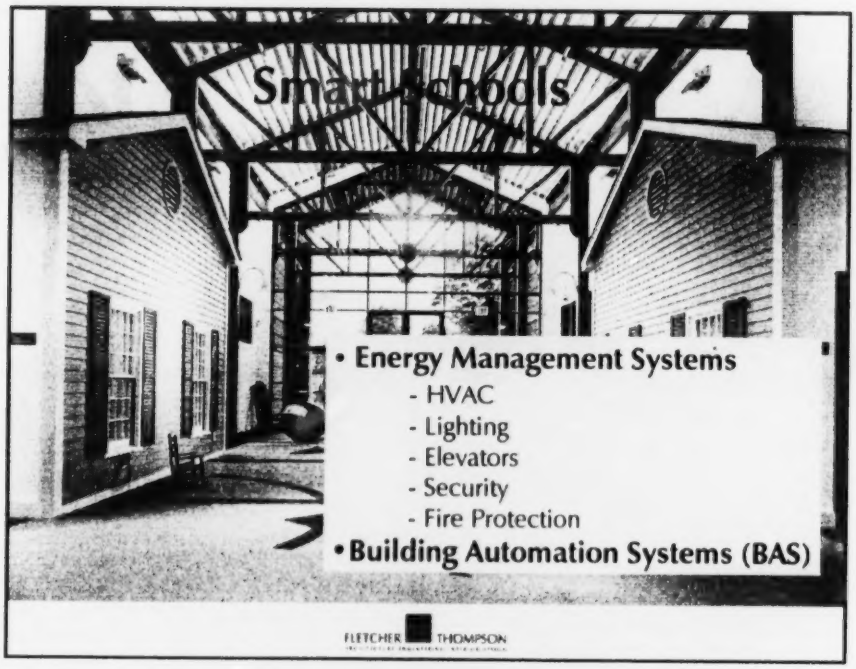

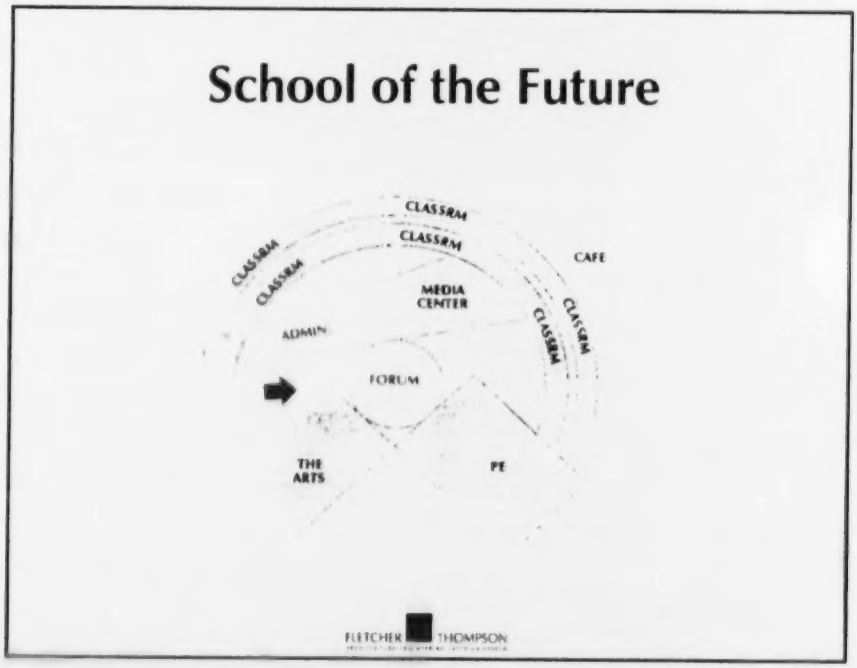

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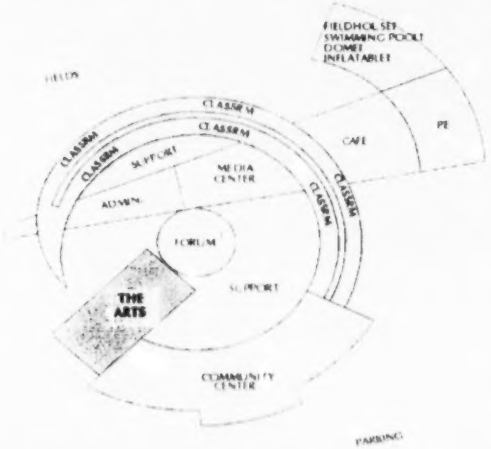
School of the Future



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